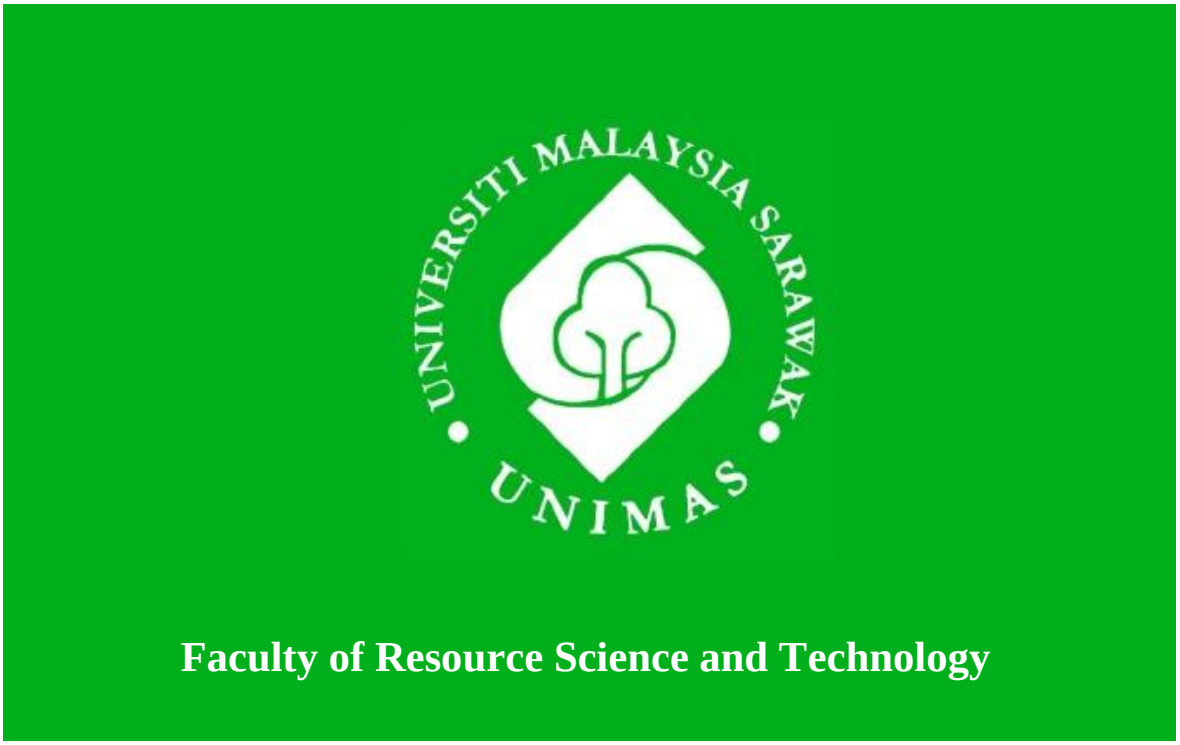

ECOLOGY AND GUT CONTENT ANALYSIS OF MUDSKIPPERS IN SELECTED MANGROVE AREAS

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Bachelor of Science with Honours
(Aquatic Resource Science and Management)
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2012

DECLARATION

I hereby declare that this Final Year Report 2012 is based on my original work except for quotations and citations, which have been duly, declare that it has not been or concurrently submitted for any other degree at UNIMAS or other institutions of higher learning.

Masyitah binti Mohd Ibrahim.

Aquatic Resource Science and Management

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LIST OF ABBREVIATIONS

Abbreviations	Description
HD	Head Depth (cm)
HL	Head Length (cm)
TL	Total Length (cm)
SL	Standard Length (cm)
BD	Body Depth (cm)
BW	Body Weight (g)
MW	Mouth Width (cm)
MH	Mouth Height (cm)
SD	Sex Determination
ADF/D1	Anterior Dorsal Fin
PDF/D2	Posterior Dorsal Fin
AF	Anal Fin
CF	Caudal Fin
ED	Eye Diameter
TOM	Total Organic Matter
%	Percentage
F	Frequency of Occurrences

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Ecology and Gut Content Analysis of Mudskippers in Selected Mangrove Areas

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ABSTRACT

A study on ecology and gut content analysis of mudskippers was conducted in mangrove areas of Telaga Air and Muara Tebas, Kuching. A total of 31 individuals of mudskippers were collected using cast net and manually collected by hands. The morphometric and meristic characteristics were observed and recorded. The body total length (TL), standard length (SL), body weight (BW), and number of fins were measured. Identification was done using key features from Murdy (1989). Thirty one specimens were dissected to collect their gut content and to determine the frequency of occurrence (%). A total of 6 food items were found and classified as organic matter detritus (fine and coarse particulate organic matter), plant fragments, sand grains, crustacean (shrimp and crab), Nematode (worm), diatoms and microalgae. The most dominant food items in gut content of *B. boddarti* were diatoms and microalgae (100 %), sand grains (80 %) and organic matter (70 %). The gut content analysis of *B. pectinirostris* indicate that the most importance food items was diatoms and microalgae (100 %), plant fragments (66.7 %) and organic matter (55.6 %). In *P. schlosseri*, major food items were crustacean (100 %), sand grains (100 %), organic matter (66.7 %) and plant fragments (33.3 %).

Key words: ecology, gut content analysis, morphology, frequency (%) of occurrences, phytoplankton

ABSTRAK

Kajian terhadap ekologi dan isi perut ikan belacak telah dijalankan di kawasan paya bakau yang terletak di Telaga Air dan Muara Tebas, Kuching. Sejumlah 31 ekor ikan belacak telah berjaya ditangkap menggunakan jala ikan dan juga tangan. Ciri-ciri morphologi dan meristik telah dikira dan direkod untuk kerja-kerja menganalisis. Jumlah panjang badan (TL), panjang standard (SL), berat badan ikan (BW) dan jumlah sirip telah dikira. Identifikasi terhadap species ikan dijalankan menggunakan rujukan daripada Murdy (1989). Sementara itu, 31 specimen isi perut ikan telah di analisis untuk mengkaji peratus (%) kejadian frekuensi. Terdapat 6 kumpulan jenis makanan yang telah dikenal pasti iaitu bahan organic/detritus, cebisan tumbuhan, butiran pasir,krustasia (udang dan ketam), nematod, diatom dan mikroalga.Makanan yang mendominasi isi perut B. boddarti diatom dan mikroalga (100 %), butiran pasir (80 %) dan bahan organik (70 %). Makanan yang paling penting terkandung dalam isi perut B. pectinirostris ialah diatom dan mikroalga (100 %), butiran pasir (66.7 %) dan bahan organik (55.6 %). Bagi P. schlosseri pula, makanan utama ialah krustasia (100 %), butiran pasir (100%),bahan organik (66.7 %) dan cebisan tumbuhan (33.3 %).

Kata kunci: ekologi, kajian isi perut, morphologi, peratus(%) kejadian frekuensi,phytoplankton

1.0 Introduction

Mudskippers constitute a group of 25 air-breathing species in four genera (Periophthalmodon, Periophthalmus, Boleophthalmus and Scartelaos) that are the most derived and the most amphibious of the ten genera of the teleost subfamily Oxudercinae (Gobiidae: Murdy, 1989). In Malaysia people called this fish as '*ikan belacak*', '*ikan layar*' and '*ikan tembakul*'. According to Murdy (1989), the highest species richness and number of endemism are found in the Indo-Malayan region, which probably is the centre of the origin of this group.

There are 3 mains species that inhabit Sarawak River which are *Boleophthalmus boddarti*, *Periohthalmodon schlosseri* and *Parapocryptes serperaster* (Atack, 2006). The differences between species can also be distinguished by size, external morphology, and body color patterns. According to Zamroni (2011), the morphological data can be divided into morphometric and meristic where morphometric are continuous data from measured structures whereas meristic are discrete data from countable structure. The meristic features were used to generate data on taxonomic differences (Lawson, 2010).

Mudskippers were restrained only in mangrove areas. Bahija and Hussain (2010) stated that mudskippers need to live in habitats that are hot and humid in order to breathe, where air and water temperature range from75 to 86 °F and humidity from 60 to 80 % and they are only active when the temperature is above 55 °F. Mudskippers have ability to breathe through skin and the lining of their mouth and throat which only possible when their body is wet, thus, limiting mudskippers to humid habitats and requiring that they keep themselves moist. Mudskippers have a high density on tidal mudflats that are found in creeks, estuaries, and on mangrove forest zone (Edun *et al.*, 2010).

The high shore mudskippers are called *Periophthalmus*, which are carnivorous mudskippers up to 15 centimeters long and feeds on little crabs at low tide. The genus

Periophthalmus is by far the most diverse and widespread genus of mudskippers that contains eighteen described species (Larson and Takita, 2004). *P. schlosseri* can also be found in the burrows, on the mudflats or at the water's edge (Takita *et al.,* 1998). According to Swennen *et al.,* (1995) *Boleophthalmus boddarti* could be found in intertidal areas vegetated by mangrove forests. *B. boddarti* inhabited a less vegetated areas of intertidal mudflats.

Two main categories on gut content analyses are as follow; i) examining the diet of a fish population with a view of species' nutritional in the context of the fish community, and ii) studies which to estimate the total amount of food consume by a fish population. This study was focused on the second category; which according to Hyslop (1980) this is possibly the simplest way of recording the number of stomachs containing one or more individuals of each food category.

Mudskippers had become special delicacies in many part of the world. Its importance lies on its availability as food for man and as baits for both artisanal and offshore fisheries. In Niger Delta region (Nigeria), the *P. koelreuteri* are economically important and actively fished by the local inhabitants of this area to whom it serves as special delicacies and as bait to catch bigger fishes (Bob-Manuel, 2011). It is reported that mudskippers cost as high as $20/kg in Taiwan and Japan (Khaironizam and Norma-Rashid (2002).

In Taiwan, mudskipper extensively cultured and in Malaysia aphrodisiac value attributed to its raw fleshes (Etim *et al.,* 1996). Meanwhile in Vietnam, it has been farmed traditionally by stocking wild-caught juveniles in ponds. The relatively high demand and a good market value for this species, intensified culture of *P. elongatus* and this practice is being considered as an alternative to shrimp farming, which carries high risks for many farmers due to chronic shrimp diseases (Bucholtz *et al.,* 2009).

1.1 Objectives

The main aims for this study are (1) to study diet properties of mudskipper in selected mangrove areas, (2) to compare the diet, morphological characteristics and ecological distribution of mudskipper, (3) to document the morphometric and meristic characteristics upon its congregations in mangrove areas. These intend to answer the question of the limited published study of mudskippers on gut content analysis in Sarawak Rivers, possible of species reduction, and no current study on anthropogenic habitat destruction whether from land activities or pollution in Sarawak mangrove areas.

2.0 Literature Review

2.1 Gut content analysis

Numerical analysis is selected because it is easiest and less time was needed to get the result. The analyses are constrained to food items found in the stomach and oesophagus to increase the possibility that the food item had been eaten recently and in the habitat where the fish caught (Wennhage & Pihl, 2002). The feeding efficiency of an individual depends on its morphology, biochemistry, physiology, behaviour, and ecological relations with individuals of the same and other species (Wainwright & Richard, 1995; Piet, 1998 as cited in to Kruitwagen *et al.*, 2007).

2.2 Diet and feeding habits of Mudskippers

Mudskippers are amphibious, fish that are highly active during low tides and spend most of their time out of water in mangrove habitats (Khaironizam *et al.,* 2002). Mudskippers are very active when they are outside the water, feeding and interacting with one another (Bahija and Hussain, 2010). Mudskippers could be classified into carnivorous and herbivorous, influenced by the availability of food sources in their surroundings. They are a carnivorous opportunist feeder. An example of carnivorous species is *Periophthalmus argentilineatus* who fed on small crabs and other arthropods (Milward, 1974 as cited in Bahija and Hussain, 2010).

2.3 Ecology of Mangrove areas

Ecology can be defined as the scientific study of the interaction between organisms and their environments (Campbell *et al.,* 1999). The mangrove mudflats have rich food supplies which allowed the mudskippers to the leave the water from time to time to feed and other activities. Different localities host different mudskipper communities and the species richness of this community should be

consistent with Malayan system or Species-Area Relationship (SAR) hypothesis (Polgar, 2008).

2.4 Soil particles analysis

The soil characteristics are among the important research that is study about mangrove areas productivity and structure. The species composition and growth of mangroves are influenced by the physical composition of mangrove soils. The proportions of clay, silt and sand, together with the grain size, dictate the permeability or hydraulic conductivity of the soil to water, which influences soil salinity and water content.

3.0 Materials and Methods

3.1 Study area

3.1.1 Telaga Air

The study was carried out in Kampung Telaga Air on 4th and 5th February 2012 (Figure 1). The study areas included Sg. Sibu Laut and Sg. Rambungan estuaries. During 4th February, the site was recorded as Station 1 (N 01° 40.643' E 110° 11.341') and on 5th February, Station 2 (N01° 41.154' E 110° 12.434'). Both stations were near to Pulau Tukong and a small village. The location was determined using Global Positioning System, GPS (Garmin, GPS map 62S). The weather was sunny on the first day (9.56 am) and cloudy on the second day (10.00 am). The *in-situ* water quality parameters of both stations were also recorded during high tides.

3.1.2 Muara Tebas

This study was carried out in Kampung Senari which located in Muara Tebas on 26th April 2012 (Figure 2). This site was recorded as Station 1. The samples were collected nearest the villager's houses approximately about 30 m from low tide areas. The mudflats were quite close to industrial areas (Brooke Dockyard and Engineering Works Corporation). The area was packed with human activities including fishing and shipment activities. Meanwhile, the selected *in-situ* water quality parameter was obtained on the jetty (N 01° 37.185' E 110° 27.134') during high tides. The weather on that particular time was sunny. The study site was chosen due to the easy access of mudflat areas.

Figure 1: Maps of Telaga Air and Kampung Telaga Air**.**

Figure 2: Map of Muara Tebas and Kampung Senari

3.2 Mudskipper sampling

A total of 11 adult mudskippers were collected, with the help from local fishermen on 4th and 5th February at Telaga Air, while 20 adult mudskippers were bought also from local fishermen on 26th May at Muara Tebas. Cast net or locally called 'jala ikan' and bare hand was used by to capture the mudskippers. The specimens was placed in labelled plastic bags, kept in ice box and transported back to laboratory for further analysis.

3.3 *In-situ* water quality parameters

Selected physico-chemical parameters of the water surface were taken at Station 1 and Station 2 of study areas on 4th and 5th February during high tides at Telaga Air. The locations were determined using Global Positioning System, GPS (Garmin, GPS map 60csx). The in-situ parameters of salinity (PSU) were recorded using seawater refractometer (Milwaukee, MA 887), temperature (°C) and pH using pH/Temperature meter (Martini, Mi 105), Dissolved Oxygen (DO) using DO meter (CT Lutron DO-5510), turbidity, NTU using turbidity meter (Martini, Mi 415), water current using flow meter (model 2000 portable flowmeter, flow mate), and depth (m).

At, Muara Tebas the water quality was taken on the jetty, also during high tides and the locations was determined using Global Positioning System, GPS (Garmin GPS map, 62S). The in-situ parameters of salinity, PSU using refractometer (Milwaukee), temperature (°C) and pH using pH meter (Hanna, HI 8424), Dissolved Oxygen (DO) using DO meter (%) (Hanna, H19146), turbidity using turbidity meter (Eutech, TN-100) and depth (ft) (Speedtech, 64501) was recorded during the field sampling.

3.4 Soils sampling

The soil samples were taken using modified syringe (corer) of 10 cm height and 3 cm diameter on the surface of mudflats. Strip transect line were used along the intertidal gradient with 5 meter for each stations of the samples taken. The samples was placed in labelled plastic bags and brought back to laboratory for further analysis.

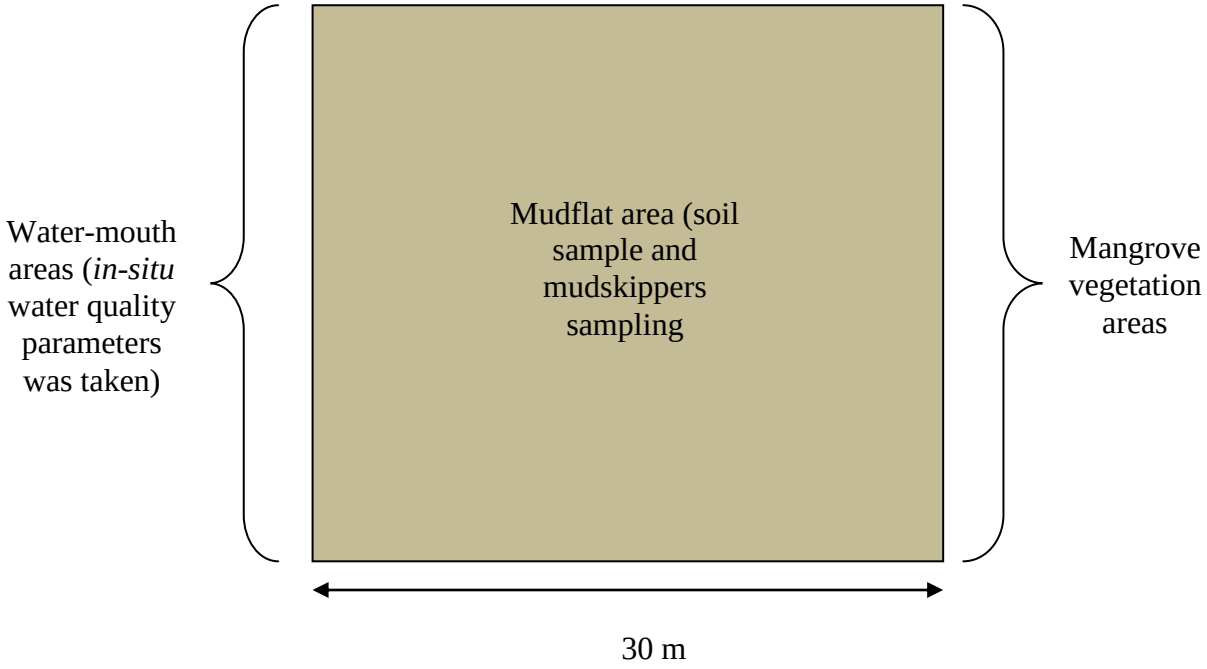

Figure 3: Illustration of study areas in Telaga Air and Muara Tebas for samples collection.

3.5 Laboratory analysis

3.5.1 Gut content analysis

A total of 31 specimens were used to study the gut content analysis. The stomach of mudskippers was dissected and the gut contents were preserved in 10 % formalin. During observation, the gut contents were spread out on a Petri dish and a few drop of distilled water was added to minimize the formalin effect. Later, food items were observed and identified under both stereo and compound microscope. Frequency of occurrences method was used for gut content analysis (Hyslop, 1980).

I. Frequency of occurrences (Hyslop, 1980)

The relative importance of different food items in each stomach were identified and recorded. Here the number of fish in which each food item occurred was recorded and expressed as a percentage of the total number of stomach being analyzed. This figure is used to estimate the proportion of the population that feed on that particular food items (Windell and Bowen, 1978).

% F = E/F x 100%

E = Number of stomachs contain a particular food item

F = total number of stomachs being analyzed

3.5.2 Identification

I. Mudskippers (Murdy, 1989)

The sexes of the mudskippers were determined by comparing the stomach or ‘belly’ size and urogenital papillae structures under stereo microscope. The morphometric characteristics were measured using vernier

calliper and ruler to the nearest centimetres (cm). The meristic characteristics were counted. Photos were taken for further identification studies.

II. Taxa composition

The food items content inside the gut were observed using stereomicroscope and then by using compound microscope (Magnus MLX 9M0456). They were identified to taxa level using available literatures. The abundances of phytoplankton were compared for different species.

3.5.3 Total organic matter (TOM) (Greiser and Faubel, 1988)

The organic matter was occupied drying at 60^{o}C for 24 hours. After the water completely removed, the initial weight of sediments was recorded. The sediment was combusted at high temperatures in furnace for 8 hours to 12 hours with temperature from 450^{o}C to 500^{o}C. Lastly, the sediments were weight as final weight to determine weight loss due to ignition. The loss of sediment weight indicates as the amount of total organic matter in the samples.

3.5.4 Soil particles analysis (Buchanan, 1984)

The particle size analysis was analysed through process of silt-clay fraction, dry sieving and pipette methods following Buchannan (1984). The sand fraction is analyzed by passing through a geometric series of test sieves. For assessment of characteristics sediment indices, the sediment weight fractions were transformed into cumulative frequency percentage and plotted as a graph.

4.0 Results and Discussion

4.1 Ecology

4.1.1 Site Observation

1. **Telaga Air**

The mangrove areas in Telaga Air were vegetated largely by *Rhizophora sp.* (Pokok Bakau) and few *Avicennia sp.* (Api-Api Putih) was seen during the observation. The water bodies were brackish water and influenced by tidal cycles. At low tides, the stilt-like prop roots were visible and intertidal mudflats were exposed which lies as a feeding ground for mudskippers. The prop-roots also served as a hide out for the mudskippers. The mudflat was sloppy and the soils are black with the smell of rotten odour. The mudflats are difficult to access by people. *Boleophthalmus* pectinirostris, *Boleophthalmus boddarti* and *Poleophthalmodon schlosseri* were caught during sampling hours (low tide).

2. **Muara Tebas**

The mangrove areas in Muara Tebas (Kampung Senari) were dominated by *Avicennia sp*. There was abundance of mudskippers along the water mouth. There were also high population densities of mangrove crab inhabiting the areas. As the study sites was nearest to the village, a lot of debris and solid waste disposal could be found. The mudflats area was longer compared with Telaga Air site areas. *Boleophthalmus pectinirostris* and *Boleophthalmus boddarti* were caught during sampling hours. However, *Poleophthalmodon schlosseri* population was rarely seen and none were caught. Even though, the study sites was located near to fishing boat harbors as well as fishing village but dense population of mudskippers were inhabit that areas.

Table 1: Showed summary of site observation in Telaga Air and Muara Tebas mangrove areas base on observation.

Study Site	Vegetation	Species	Slope	Mudskippers
Telaga Air	Dense	*Rhizophora sp.* *Avicennia sp.*	Gradient	*B.pectinirostris* *B.boddarti* *P.schlosseri*
Muara Tebas	Less	*Rhizophora sp.* *Avicennia sp.*	Sloppy	*B.pectinirostris* *B.boddarti*

*Less (few vegetation on mudflats as shown in Figure 4)
*Dense (high vegetation on mudflats as shown in Figure 5)

In Muara Tebas, most abundance species found during sampling hours was *Boleophthalmus pectinirostris* which scattered around the water pools. In this areas there, was no *Periophthalmodon schlosseri* were caught. The absence of P. schlosseri during this study may be because Muara Tebas sampling site was located near to fishing boat harbours as well as fishing village and large amounts of garbage can be seen on the mudflats.

According to Takita (1998), *P. schlosseri* were found on seashore and tidal river mudflats, adult typically constructing burrows comparatively high on the intertidal areas, often close to adjacent vegetation. However, the high tide areas in Muara Tebas sampling site were disturbed to allow residential of human. Mudskippers adapted to such an environment are seemingly able to survive even in the presence of man-made contamination.

B. boddarti species could be found in both sampling areas. Based on studies by Takita (1998), many individuals of this species aggregated at the water edge during low tide. This allowed local fishermen being able to catch this species from such aggregations with casting nets.